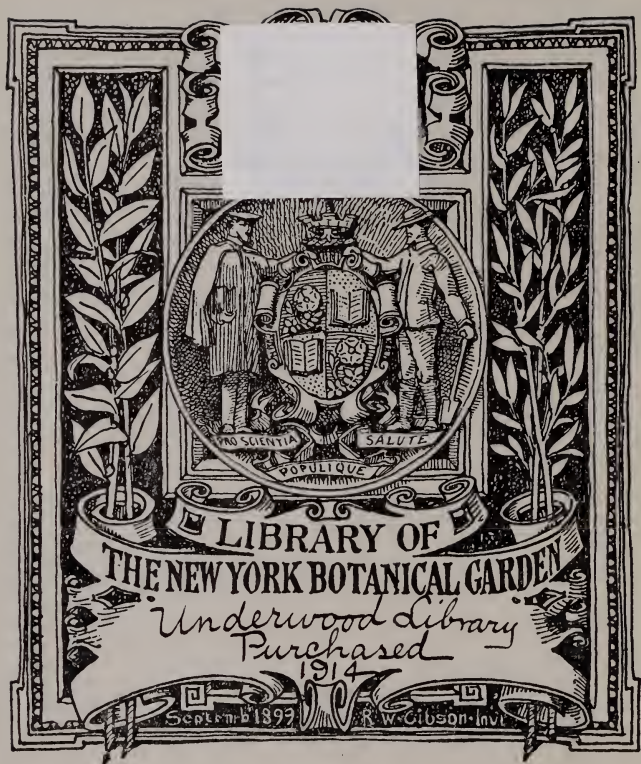


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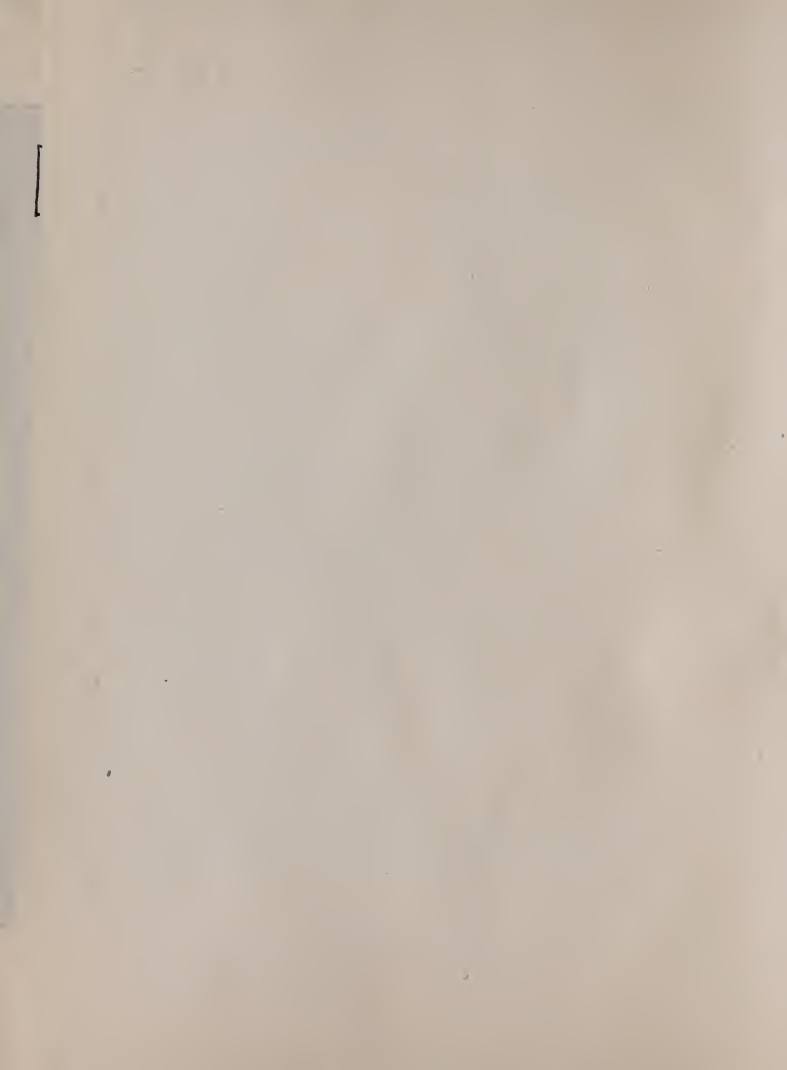
FERNS
AND
FERN ALLIES
OF NEW ENGLAND.

RAYNAL DODGE.



L. M. Underwood

Dec. 1896.





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DRYOPTERIS SIMULATA DAV.

Fig. 1. Sterile frond.

Fig. 2. A fruiting pinnule.

Fig. 3. A pinnule slightly magnified to show venation.

—THE—
FERNS
AND
FERN ALLIES
OF NEW ENGLAND.

BY
RAYNAL DODGE.

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PREFACE.

TO those fond of nature, and desirous of intimate acquaintance with a part of her manifold works, the study of Ferns commends itself in an alluring way. The variety in form and beauty of the living plants invite the attention, whilst their scarcely less attractive appearance when preserved render a collection of the species of any locality an object of interest.

The cultivation of our native ferns is an added attraction, many of them thriving under ordinary conditions of soil, shade and moisture, whilst most of the others can be grown with a little attention to soil and drainage. A few do best in Wardian cases. The Ferns and Fern Allies, Vascular Cryptogams, Vascular Acrogens, or Pteridophyta, as they are variously termed, comprise in New England eighty-two species, distributed as follows: Filices, 45; Ophioglossaceæ, 7; Equisetaceæ, 8; Lycopodiaceæ, 9; Selaginellaceæ, 3; Marsiliaceæ, 1; Salviniaceæ, 1; Isoetaceæ, 8. If with these are included their well marked varieties, the total number would be about one hundred.

Many of these species are peculiar to certain districts. Some are found in New England only on the mountains and higher land of our northern sections; two at least, *Woodsia alpina* and *Asplenium viride*, having been noticed only in Vermont, whilst two others, *Asplenium montanum* and *Asplenium ebenoides* are not known within our limits excepting from Connecticut. The calcareous district west of the Connecticut river is the home of several species rarely found on its eastern side, and several others are nearly confined to the vicinity of the Atlantic seaboard. In like manner *Marsilea quadrifolia* is native only to a lake near Litchfield, Conn., and *Isoetes Tuckermanni* has scarcely been found but in ponds in the vicinity of Boston.

JUL 1, 1914

The larger part of our true Ferns require shade and much moisture, but a few, as *Woodsia ilvensis*, will thrive on hillsides exposed to full sunlight. *Dryopteris fragrans* and apparently *Asplenium montanum*, grow under shelving ledges, getting their moisture from the atmosphere, and several of our evergreen ferns are found in quite dry but shaded situations. Ferns, although thriving in damp situations, are seldom found growing in water, but *Osmunda regalis* is occasionally seen flourishing in the bed of a brook, and one of our species, *Asplenium filix-fœmina*, seems capable of adapting itself to almost any environment. In the family Ophioglossaceæ, *Ophioglossum vulgatum*, *Botrychium simplex* and *Botrychium ternatum*, thrive best in the open sun. In Lycopodiaceæ all grow in the shade, but *Lycopodium inundatum*. Nearly all the Equisetaceæ and all the Isoetaceæ, require abundance of both sun and water, indeed, two species of Isoetes, *I. lacustris* and *I. Tuckermanni*, are usually submerged to the depth of several feet.

There is much difference in the dimensions attained by our native ferns, *Onoclea Struthiopteris* under favorable circumstances reaching the height of eight or ten feet, while the fronds of the little *Asplenium ruta-muraria* are only one or two inches long.

In the following pages an attempt has been made to furnish students and collectors with a ready means of identifying the species and varieties of the ferns and their allies native to the New England states, to give their natural surroundings, and in the case of the more uncommon species, their stations; and particularly to give as accurately as possible the proper time for their collection, which latter has possibly never before been attempted. To this end every available source of information has been utilized, including Underwood's "Our Native Ferns," Gray's Manual, Hooker's "Synopsis Filicum," Wood's "Botanist and Florist," Eaton's "Ferns of North America," and the many local lists which have been published. Much has been gleaned from an extensive correspondence with collectors, and much as regards the chronological list from the author's personal observations. Although prepared for

the northeastern sections of our country, it is to be borne in mind that there are very few plants in this list which do not occur in the Middle states; in fact there are only twenty-five others in the whole Gray's Manual range.

It is hoped that the remarks on the literature of our subject will render this little book suggestive to beginners for whom this work is mainly intended, although perhaps even the life-long student may glean something from its pages.

The term *frond* as applied to ferns, is often used both by botanical writers and in ordinary conversation, to include both stalk and leafy portion. At other times it is evidently the leafy part alone which is referred to. As it is very desirable that the term should not be thus loosely applied, the *frond* is here considered to comprise both stipe and blade, the blade being distinguished by the term *lamina*, first used in this sense we believe by Mr. George E. Davenport.

The arrangement of orders and families, and also the species numbers here given, are the same as in the "The Pteridophyta of North America North of Mexico," or No. 9 of the *Linnean Fern Bulletin*."

The accented syllable of all generic and specific names occurring in the succeeding pages has been designated, the grave accent ` denoting the full long sound of the vowel and the acute accent ´ the short sound. The Italian method of Latin pronunciation has not been generally introduced into botanical nomenclature, although it has been in use in the schools of some sections of the country for many years. There are consequently in common use two methods of pronouncing Greek and Latin words. The following rules are given with a view of making more familiar the older, and in biology the method generally accepted among English speaking people. A word has as many syllables as it has vowels and diphthongs; but in the construction of words derived from personal names, the name is given a Latin termination, the pronunciation remaining otherwise unchanged, as in *Eatoni*. A at

the end of a word, is like *a* in *father*; as in *bulbifera*. *I* at the end of a word is like *i* in *mile*; as in *Tuckermanni*. *U* unaccented, like *u* in *tun*; as the first *u* in *atro-purpurea*; *u* accented like *u* in *tune*; as the second *u* in *atro-purpurea*; *æ* and *æ* are diphthongs and are pronounced as the long *e* would be in English in the same situation; *au* as in *fraud*, but in words derived from Germanic proper names like *ou* in *house*, as in *Braunfi*; *eu* like *u* in *tune*; as in *platyneuron*; *oi* as in *boil*; as *ebenoides*. *C*, before *e*, *i*, *y*, and the diphthongs *æ* and *æ*, has its hissing sound, in other situations it is pronounced like *k*, as in *Cystopteris*, *complantum*, *saccharata*. *G* before *e*, *i*, *y*, *æ* and *æ*, has the sound of *j*; as in *marginale*; otherwise it has the sound of *g* in *go*; as in *hexagonoptera*. *Ch* has always the sound of *k*; as in *Botrychium*. *P* is silent in *Pteris*, but is sounded in its compounds, as in *Dryopteris*, *Thelypteris*. All other vowels, consonants and their combinations are pronounced nearly as in English.

I am indebted to correspondents from all over New England for specimens and information. Many of their names are given in the text. I would especially mention Mr. Alvah A. Eaton to whom I owe many thanks for valuable assistance in the preparation of these pages.

RAYNAL DODGE.

Newburyport, Mass.,

Nov. 1896.

FAMILY I, FÍLICES Juss.

FLOWERLESS plants, circinate in veneration; leaves usually much divided, raised on a stalk, some or many of them bearing on the under surface or along the margins of the divisions, small spore cases (sporangia), which are often collected in clusters (sori) and contain very many minute spores, all of one kind; fertile fronds, or their fertile portions, sometimes much contracted and changed in appearance, causing the sporangia to appear as if in panicles or spikes. In the following descriptions, the frond is considered to include both leaf and stalk, and the leafy portion to be the lamina; the stipe is the portion of the frond between the rootstalk and the lamina, and the rachis its continuation through it.

Sub-Family I, Polypodiaceæ Presl.

Sori, either on the dorsal side of the lamina collected in clusters or forming lines along the edge of its divisions. Sporangia surrounded by vertical, elastic rings, bursting transversely and scattering the spores.

TRIBE II, POLYPÒDIEÆ.

Represented by a single genus, and with us by a single species.

POLYPÒDIUM L.

2. P. vulgàre L. POLYPODY. Fronds 4-12 inches long; laminae 1-3 inches wide, nearly pinnate; sori collected in large, brownish-yellow dots, with no indusia. Evergreen. Aug-Dec. Everywhere common on cliffs and rocks, usually in half shade. Europe, Japan, etc.

Illustrated by Meehan, Series I, Vol. 2, and in Gray's Manual.

Var. *Cambricum* is a form in which the lamina instead of being lobed is pinnate, the pinnæ broad and overlapping, and themselves toothed and lobed. Seldom fertile.

Illustrated by Anne Pratt, and in Eaton's Ferns of N. A.

TRIBE V, PTERÍDEÆ.

Fructification marginal or intra-marginal, the reflexed margins of the segments of the lamina serving as indusia. In our region are included three genera, with four species.

ADIÁNTUM L.

36. A. pedàtum L. MAIDEN HAIR. Fronds 8-24 in. high, forked at the top of the black, shining stalk, the divisions once to thrice pinnate; ultimate segments very numerous, triangular oblong; sori roundish, beneath the membranaceous inwardly turned margins of the ultimate segments. Moist woods and shaded hill-sides. Generally distributed, but in most sections not common. North America generally, northern India and Japan. Aug.-Oct.

Illustrated in Gray's Manual.

PTÉRIS L.

41. P. aquilìna L. COMMON BRAKE. 1-6 feet high; frond ternate, the divisions twice pinnate; sori forming a continuous line along the margin of the oblong-lanceolate ultimate divisions. Well drained soil, usually in half shade. Common throughout New England, and distributed throughout the world. September.

Illustrated in Gray's Manual.

A form of this fern occurs in which the frond is several times pinnate, but not ternate.

PELLÆA LINK.

67. P. grácilis (Michx.) Hook. SLENDER CLIFF BRAKE. Stipes brown and shining, 2-3 inches long; laminæ smooth and delicate,

2-5 inches long; fronds dimorphous, twice or thrice pinnate. Ultimate divisions of the sterile frond broad and blunt, of the fertile frond narrow and lanceolate; sori finally forming a continuous line covered by the broad, membranaceous, reflexed margin of the fertile segment. Damp and shaded calcareous rocks. Rare. The known New England stations of this fern are nearly all in Vermont: Norwich, *Dr. Edward Hyde*; Mt. Willoughby, Mt. Mansfield; Sunderland, Mass, *Prof. Tuckerman*; *A. T. Beals*.

May be expected in the western portions of Mass. and Conn., and in Northern N. H. Grows in the Himalaya mountains, and a nearly allied form is found in Europe. Middle of July.

Illustrated in Gray's Manual.

68. *P. atropurpurea* (L.) Link. DARK PURPLE CLIFF BRAKE. Stipes dark purple and shining, 2-6 inches long; laminae 4-12 inches long, coriaceous, pinnate or below bipinnate; divisions very variable in form; sporangia forming a continuous marginal line, covered by the slightly altered involute edge of the ultimate segments. Dry calcareous rocks. Mt. Horr; Snake mountain, Weybridge, Vt, *Eggleston*. Deerfield, Leverett and Greenfield, Mass., and not rare in western Conn. Late in July.

Both species of *Pellaea* are apparently confined to that portion of New England west of the Connecticut river. North American.

Illustrated by Meehan, Series II, Vol. 2.

TRIBE VII, BLÉCHNÉÆ.

Sori dorsal, linear, on veins parallel to the midveins of the ultimate divisions of the frond, and furnished with special indusia opening on the inner side. In our section one genus, with two species.

WOODWÁRDIA J. E. SMITH

85. *W. Virginica* (L.) Smith CHAIN FERN. Fronds 2-4 feet long; laminae glabrous, lanceolate, once pinnate, with remote pinnatifid pinnæ; sori at length confluent; sterile and fertile

fronds similar, resembling those of *Osmunda cinnamomea*. Wet swamps and borders of ponds; rare in the interior. Colchester, Vt.; Belchertown, Mass.; West Granby, Conn.; becoming quite common near the coast. Often sterile, especially in dense shade. North American, and mainly on the Atlantic seaboard.

Illustrated by Meehan, Series II, Vol. 2

■ **86. *W. areolata*** (L.) Moore. (*W. angustifolia*.) Fronds dimorphous, the sterile pinnatifid, with broad serrate divisions and green stipes, the fertile nearly pinnate with narrow divisions nearly covered beneath with the linear sori; stipes of the fertile fronds dark brown and shining; sterile frond resembling that of *Onoclea sensibilis*, but its veins are reticulated. Hadley and Deerfield, Mass.; East Haddam, Conn.; becoming more common near the coast, but much less so than the preceding species. Same range. Late in September.

Provokingly sterile at some stations. Both species of *Woodwardia* fruit when transplanted into half shade.

Illustrated by Meehan, Series II, Vol. 1.

TRIBE VIII, ASPLÈNIEÆ.

Sori dorsal, linear, on veins oblique to the mid-vein, and furnished with special indusia which are attached on one side to the fertile vein and open on the other. With us two genera, one with nine species and one with a single species.

ASPLÈNIUM L.

Sori on the upper side or rarely on both sides of the veinlet; veins free.

89. *A. ebenoides* R. R. Scott. "Fronds 4-9 in. long, broadly lanceolate, pinnatifid, pinnate below, the apex prolonged and slender; divisions lanceolate from a broad base, the lower ones shorter, often proliferous, as is the apex of the frond; stipes lustrous black, as is the lower part of the midrib, especially beneath." —*Prof. D. C. Eaton*.

Fronds usually more or less abortive. Probably a hybrid be-

tween *Campptosorus rhizophyllus*, the Walking fern, and *Asplenium platyneuron*, the Ebony spleenwort, and to be expected to occur sparingly where these ferns grow in proximity. Some of those who have access to living plants of this species should test the fertility of its spores. Distributed throughout the United States east of the Mississippi river, but very rare in New England. One or two plants have been found near Canaan, Conn., *Adam*. August.

Illustrated in Eaton's]Ferns of N. A., Vol. 1, and by Meehan, Series II, Vol. 1.

90. A. platyneuron (L.) Oakes (*A. ebenum*.) EBONY SPLEENWORT. Fronds 5-20 inches long, erect; laminae once pinnate; pinnae mostly alternate, lanceolate, $\frac{1}{4}$ -1 inch long, auricled at the base; stipe and rachis lustrous brown. Dry rocky soil, often in company with Red Cedar (*Juniperus Virginiana*) Common. Middle of August. North America east of the Mississippi.

Illustrated by Meehan, Series I, Vol. 1.

93. A. Trichomanes L. MAIDENHAIR SPLEENWORT. Tufted. Fronds numerous, 3-6 inches long, spreading, simply pinnate; pinnae mostly opposite, roundish and small; stipe and rachis lustrous black. Evergreen. Shaded ledges, either calcareous or granitic. Rather frequent, but becoming rare in the neighborhood of large cities. Middle of August. Distributed throughout the world.

Illustrated by Meehan, Series I, Vol 2.

94. A. Trichomanes incisum. Laminae broader; pinnae sometimes much incised. Norwich, Vt, *Prof. Jessup*; Brattleboro, Vt.

A. Trichomanes under cultivation often takes on incised pinnae sometimes to a very marked degree, perhaps caused by growth in a stronger light, as is the case with variety *incisa* of the common Christmas fern. It may be expected perhaps in localities where this fern is abundant and its shade has been removed by the woodcutters. Fine plants of this variety occur on the Pacific coast. It is also native to Great Britain

Illustrated in Anne Pratt's "Ferns and Flowering Plants of Great Britain."

96. *A. viride* Huds. GREEN SPLEENWORT. Stipes tufted, chestnut brown; fronds 4-10 inches long, simply pinnate; pinnae ovate or rhomboidal, crenately toothed, Evergreen. Shaded cliffs in Northern Vt.; Sterling Mt., Mt. Mansfield, Smuggler's Notch, and extending across our northern border to the Pacific. Rare. Middle of September. Europe and Himalaya mountains.

99. *A. angustifolium* Michx. NARROW-LEAVED SPLEENWORT. Fronds 1-3 feet long; laminae simply pinnate, very thin; pinnae lance-linear and acuminate, those of the fertile fronds narrower; sori 20-40 each side of the midvein; stipes green. Damp ground; not common and nearly confined to that section of country west of the Connecticut river. Mt. Toby, Leverett, Mass.; Berlin and Meriden, Conn.; Danville, Vt. September. North American

This fern is usually sterile when in complete shade, but will fruit if transplanted into more sunny situations.

101. *A. ruta-muraria* L. WALL RUE. Very small, 1-2½ in., bipinnate below, simply pinnate above; divisions few, petiolate, cuneate to obvate, toothed at apex; sori few, soon confluent. Evergreen. Calcareous rocks. Mt. Toby, Mass.; Southington, Berlin, Canaan, Conn.; Mt. Willoughby, Mt. Mansfield, and Snake mountain, Vt. Scarce. August. Northern Europe and Asia.

102. *A. montanum* Willd. MOUNTAIN SPLEENWORT. Small, 2-8 inches; bipinnate; divisions parted into 3-7 two or three-toothed segments. East Haddam and Lantern Hill, N. Stonington, Ct. Very rare in our region. Peculiar to the United States. Cliffs and rocks. Evergreen. Middle of August.

This fern appears to be in fair condition at all seasons.

107. *A. acrostichoides* Swz, (*A. thelypteroides* Michx) SILVER SPLEENWORT. Tall, 1-2 feet; laminae pinnate; pinnae deeply pinnatifid; segments crowded, those of sterile fronds very obtuse; two rows of distinct linear sori; rachis winged. Rich woods and

moist shady banks. Generally distributed, but not common, the stations being usually small. Middle of August. Asia.

108. A. *filix-fœmina* (L.) Bernh. LADY FERN. Usually tall, 6 inches to 5 feet; laminæ twice pinnate, pinnules lance-linear, incised; sori short, curved, finally confluent. August to October. Throughout the world. Very variable, the following being the most distinct native varieties:

a. Var. *exile* D. C. Eaton. Small, growing in very dry situations. Not common.

b. Var. *angustum* D. C. Eaton. Laminæ narrow; pinnæ oblique, ascending, at length confluent. In dry situations fully exposed to the sunlight.

c. Var. *cyclosorum* Ruprecht. Fronds very large, often 4-5 feet high, 18-20 inches broad, nearly tripinnate; sori nearly annular. Wet places in the open sun.

CAMPTOSORUS LINK.

Sori oblong or linear, partly on veins paralld to the midvein, and partly on oblique veins, causing them to appear irregularly scattered.

110. C. *rhizophyllus* (L.) Link WALKING FERN. Fronds lanceolate, 6-12 inches long; laminæ usually auricled at the base, and gradually tapering into a slender prolongation which often roots at the point. Shaded calcareous rocks. Mt. Toby, Leverett, Mass.; Lebanon, N. H.; Shapleigh, Me.; and not rare in Western New England. Forked fronds of this species are occasionally found with a little plant growing at each prolongation. August. North America, principally east of the Mississippi.

Illustrated in Gray's Manual, and by Meehan, Series II, Vol. I.

TRIBE IX, ASPÍDIEÆ.

Sori round or nearly so, on the back or rarely on the apex of a vein and furnished with special indusia, (wanting in *Phegopteris*.) With us, five genera, including twenty-four species.

PHEGÓPTERIS FEE.

Sori round, rather small; no indusium.

111. P. Phegóptēris (L.) Underw. BEECH FERN. Fronds 3-20 inches long; laminae triangular, longer than broad, bipinnatifid; pinnae linear-lanceolate, the lowermost pair standing forward; basal segments of each pinna adnate to the main rachis; sori near the margin. Damp woods and shaded banks. Abundant in northern, less so in southern sections. Early July. Around the world between the 36th and 66th parallels, north latitude.

112. P. hexagonóptera (Michx.) Fee. ANGLED POLOPODY. Fronds 5-20 inches long; laminae triangular, broader than long, bipinnatifid; pinnae linear-lanceolate, the lowermost pair very large, standing forward and upward, with pinnatifid pinnules; basal segments adnate to the main rachis, and connected, forming a many-angled wing; sori near the margin of the ultimate segments, some between the sinus and midvein. Plant growing in dryer situations maturing later, and with more distant pinnae than in *Phegopteris Phegopteris*. Fragrance powerful and peculiar. Generally distributed, but most common in R. I. and Conn. Latter part of August. Occurs only in the U. S., principally east of the Mississippi river.

114. P. Dryóptēris (L.) Fee. OAK FERN. Fronds ternate, the three divisions stalked and bipinnate. Light green. Moist, shaded banks. Common northward, less so in southern sections. Easily preserved and very pretty. June. Across Northern North America and in Northern Europe and Asia.

DRYÓPTERIS L. (ASPIDÍUM.) SHIELD FERN.

Sori dorsal; indusia round and peltate, fixed by the center, or reniform, and fixed by the sinus, opening all around the margin.

120. D. acrostichóides (Michx.) Kuntze. CHRISTMAS FERN. Fronds thick, rigid and evergreen, 1-2½ feet long, lanceolate, once pinnate; pinnae linear-lanceolate, scythe-shaped, auricled on the upper side and furnished with bristly teeth; fertile pinnae contracted, bearing soon confluent sori; indusium orbicular, fixed by its de-

pressed center. Rocky woods. Common and well known July. Only in the United States, east of the Mississippi.

Illustrated by Meehan, Series 1, Vol. 2.

a. Var. *incisa* is a form in which the pinnæ are much incised, and in fertile fronds nearly all of them fruit bearing. Occasionally the whole under surface of the lamina is covered with sori. Most common in recent clearings.

127. *D. aculeata* Bräunii (Spenner) Underw. Fronds thick, rigid and evergreen, 1-2½ feet long, spreading; laminæ lanceolate, tapering both ways, bipinnate; pinnules ovate to oblong, truncate, almost rectangular at the base, covered beneath with chaff and hairs; indusium orbicular fixed by its depressed center; stipe very shaggy. Randolph and Williamston, Vt., *Small*. Gorham, N. H. *Deane*. Common in Northern Maine, *Fernald*. August.

Frequent by mountain brooks in Northern New England. A variety of the very variable *D. aculeata* which in one form or another is represented all over the earth.

128. *D. noveboracensis* (L.) Asa Gray. NEW YORK FERN. Fronds 1-3 feet long, gradually tapering from the middle both ways; laminæ once pinnate; pinnæ lanceolate, pinnatifid, the lowermost pairs gradually shorter and deflexed; veins simple; sori small; indusia minute and glanduliferous. Very common in woodlands. Middle of August. North America, east of the Mississippi.

131. *D. simulata* Dav. Fronds 1-3½ feet long; laminæ 7-22 inches long, 2-7 inches broad, oblong-lanceolate, gradually, or in the fertile fronds abruptly narrowing to a long, acuminate apex; pinnæ elliptic-lanceolate, sessile, deeply pinnatifid, the lowermost wider and introrse; pinnules only partially revolute, but the whole pinna often conduplicate; venation simple; indusia glandular; sori large; spores bright brown; bases of the stipes of previous years persistent. In sunny situations much resembling var *angustum* of *A. filix-femina*. Position and general form of lower pinnæ much as *Phegopteris Phegopteris*, causing them to appear deflexed after the frond has been subjected to pressure. Usually accompanies

Woodwardia areolata. In Maine—Southport and Foxcroft, *M. L. Fernald*; Indian Point, Georgetown, *G. E. Davenport*. In N. H.—Seabrook and Kingston. In Mass.—Salisbury, Newbury, Roxbury, Lynn, etc. New London, Conn., *C. B. Graves*. Maryland, *C. E. Waters*. “Woodland swamps, thriving best in deep shade, near cool, moist hummocks in beds of sphagnum.”—*Davenport*. Sept. Apparently confined to the vicinity of the Atlantic coast. A more detailed account by Mr. Davenport is to be found in the *Botanical Gazette* for Dec., 1894, whence much of this description is taken.

Illustrated in *Linnean Fern Bulletin*, VOL. IV, No. 3.

133. *D. Thelypteris* (L.) Asa Gray. MARSH FERN. Fronds 1–2½ feet long; laminæ lanceolate, pinnate; pinnæ linear-lanceolate, pinnatifid, the lowermost pair as long as any; margins of the pinnules reflexed over the sori; veins forked; indusium smooth; spores very dark brown. Plant with thicker and darker green fronds than *D. simulata*. Perfectly sterile in deep shade. Swampy fields; very common. August. Over most of the north temperate zone, and in South Africa and New Zealand.

136. *D. fragrans* (L.) Schott. FRAGRANT SHIELD FERN. Fronds 4–13 inches long; laminæ tapering both ways from the middle, once pinnate; pinnæ linear-oblong, pinnatifid, the divisions toothed or entire, nearly covered beneath by large, orbicular, ragged indusia; sori soon confluent; stipe short and chaffy. Plant aromatic and evergreen. High cliffs; mountains of Northern New England. In Maine—Aroostook county, *M. L. Fernald*. Mt. Kineo, *C. E. Smith*. Andover, *J. A. Allen*. Shelburne, N. H., *Deane*. Alpine cascade and gulch, White mountains, *H. Willey*. Mt. Mansfield and Camel’s Hump, Vt. Middle of August. Asia and America.

Illustrated by Meehan, Series II, Vol. 1.

138. *D. cristata* (L.) A. Gray. CRESTED FERN. Fronds 1–3 feet long; laminæ linear or lanceolate, once pinnate; pinnæ triangular-oblong, or the lowest nearly triangular, deeply pinnatifid; segments 6–10 pairs, toothed and serrate; a row of fruit dots each side of the midvein, as near the midvein as its margin; indusium large

and persistant. Swamps. Common and very variable. July. Europe.
Illustrated by Meehan, Series II. Vol 3.

139. *D. cristata Clintoniana* (D. C. Eaton) Underw. CLINTON'S CRESTED FERN. Fronds 2-4 feet long; pinnae ablong-lanceolate, broadest at base or just above the base, 4-6 inches long, its divisions 8-16 pairs; veins not conspicuous; sori near the midvein; indusium orbicular, smooth; sides of the sinus often overlapping. Swampy woods. Rare in New England, attaining its best development in western sections. Near Mt. Toby, Leverett, Mass., *A. T. Beals*. Hanover, N. H., July. Fine for cultivation.

The eastern form is much smaller, with more triangular pinnae, fewer pinnules, and sori near the margin, and hardly corresponds to Prof. Eaton's description.

One pinna illustrated by Eaton, II, Plate LXVI.

140. *D. Goldieana* (Hook.) Asa Gray. GOLDIE'S SHIELD FERN. Fronds 2-4 feet long; laminae broadly oval or ovate, once pinnate; pinnae 6-9 inches long, deeply pinnatifid; divisions about twenty pairs, slightly scythe-shaped, crenate and serrate; sori very near the midvein; indusium very large, orbicular, with a narrow sinus, its sides overlapping. Fairfield, Me., *J. A. Allen*. Spencer, Mass., *Miss A. E. Tucker*. Mt. Toby, and frequent west of the Connecticut river. Damp, rich woods in calcareous districts. July. Canada to Kentucky.

142. *D. marginalis* (L.) Asa Gray. MARGINAL SHIELD FERN. Fronds 1-3 feet long; laminae thick, smooth, ovate-oblong, twice pinnate, the lower pinnae pinnatifid toothed; pinnae lanceolate, acuminate, broadest just above the base; sori very near the margin of the obtuse or obtuse-falcate segments; base of the stipe beset with scales. Common on rocky shaded hillsides. North America, extending from Canada to Alabama, and northwestward to the Rocky mountains. July.

In dry situations this fern sometimes matures its fruit when only three inches in height.

D. cristata \times **marginalis** Dav. Fertile fronds in a crown. 1-2½ feet long; laminæ elliptic-lanceolate, long acuminate, often misshapen; sterile fronds proportionately longer than in *D. cristata*; pinnae deeply veined, long acuminate, those of the sterile fronds rumpled; lower pinnae as in *D. cristata*, upper as in *D. marginalis*; sori small, near the margin, often abortive. Usually at the foot of declivities with *D. marginalis* above it, and *D. cristata* in the bordering swamp. Often found growing in clumps. Boxford, Newbury, Merrimac and Medford, Mass.; Hampton Falls, N. H.; Warren, R. I., Dover, Me., *M. L. Fernald*; and probably infrequent throughout our range. Middle of July. See Mr. G. E. Davenport in *Botanical Gazette*, December, 1894.

144. D. spinulosa (L.) Kuntze. SPINY SHIELD FERN. Fronds 1-2½ feet long; laminæ bipinnate, ovate, acuminate; pinnae elongated, triangular, oblique to the rachis, the lower-most broadly triangular; pinnules oblique to the midrib, their segments with spinulose teeth; stipe with a few pale brown, early deciduous scales; indusia without marginal glands; soon withering. This is the typical form, var. *vulgare* Eaton, and is common in damp woods, at least near the coast. June. Europe.

In some situations matured plants are found 3-5 inches high, answering to var. *dumetorum*.

Illustrated by Anne Pratt.

145. D. spinulosa intermedia Willd. Laminæ broader than in typical plant, often tripinnate; pinnae nearly at right angles with rachis; pinnules more crowded and finely dissected, the next but one to the rachis often longest, especially on lowermost pinnae; ultimate segments less spinulose; indusia furnished with marginal glands; scales of the stipe brown with a darker center. North American. Late in June, and scattering through the summer.

The lower pinnae of this variety are sometimes much dilated, the pinnules next the rachis reaching the length of four inches, corresponding to the dilated form of the typical plant.

146. *D. spinulosa dilatata* Hoffm. This is a more highly-developed form of the typical plant, the lower pinnæ at times being very broad and fronds often tripinnate; indusium smooth. Attains its best development in the northern sections. June. Europe.

147. *D. Boottii* (Tuck.) Underw. Fronds 1-2½ feet long. Laminae ovate-lanceolate, bipinnate; upper pinnæ lanceolate, the lower triangular, both with crenate, spinulose teeth. Sori in rows each side of the midvein, one to each tooth or scattering on the pinnules next the rachis, indusium large, minutely glandular. Variable. Frequent in shaded swamps, apparently most so in eastern sections. North American. July.

CYSTOPTERIS BERNH. BLADDER FERN.

Sori dorsal, roundish; indusium hood-shaped, fixed by a broad base, opening towards front side and soon thrown off.

151. *C. bulbifera* (L.) Bernh. BULBOUS BLADDER FERN. Fronds long lanceolate, 1-2 feet, bipinnate; pinnæ lanceolate-oblong, lowermost pair longest; pinnules crowded, bearing bulblets beneath; indusium obtuse on the free end; stipe short; rachis wingless. Shaded ravines in calcareous districts. Mt Toby, Mass.; Guilford, Conn.; Mt Willoughby, Vt. West of the Connecticut river, and in Northern N. H. and Northern Me. North America, east of Arkansas and north of Tennessee. Late in July.

152. *C. fragilis* (L.) Bernh. FRAGILE BLADDER FERN. Fronds 5-12 inches long; laminae lance-oblong, bi-tripinnate; stipe longer than in the preceding species and very brittle; rachis winged; indusium acute on front side. Very variable. Damp shaded places, usually disappearing in August. Common, but easily overlooked. Early July. One of the most universally distributed ferns; found from Arctic regions to the southern extremities of the continent, and in New Zealand.

ONOCLEA L.

Sori enclosed in the revolute segments of the contracted fertile frond. Sterile fronds very different from the fertile.

154. *O. sensíbilis* L. SENSITIVE FERN. Sterile fronds 6 inches to 3 feet, scattered along a creeping rootstock. Laminæ triangular-ovate, deeply sinuate-pinnatifid, reticulate veined. Fertile fronds bipinnate, much contracted, their revolute segments berry-like. Sterile fronds throughout the summer; fertile fronds middle of September. Very sensitive to frost. Abundant in damp soil. United States east of the Mississippi, and Japan.

Illustrated by Meehan, Series II, Vol. 1.

a. Obtusilobata is an occasional form in which the normally sterile frond has its segments revolute, enclosing a few usually abortive sori. Fronds of this nature are usually quite small, and are to be expected in situations where the fern has suffered an injury, as by cropping early in the season, or where growing in very dry situations. August.

155. *O. Struthiópezteris* (L.) Hoffm. OSTRICH FERN. Sterile fronds 1-10 feet, in a crown; laminæ pinnate, the pinnæ recurved and deeply pinnatifid; pinnæ numerous, becoming gradually smaller towards the channelled stipe. Fertile fronds 6-18 inches, contracted, simply pinnate; margins of the pinnæ revolute into a necklace form containing the sori. Along streams and in moist places; most common in western sections.

This fern when growing in dry situations, especially if the sterile fronds have suffered injury, sometimes produces fronds analogous to those of *O. sensíbilis obtusilobata*. Sterile fronds throughout the summer; the fertile late in August. Northern Europe and Asia.

WOODSIA R. BR.

Sori roundish; indusium fixed beneath and enclosing the sori, soon bursting and developing a hairy fringe, or in case of the last species, splitting into irregular lobes. Four species in New England.

156. *W. Ilvénsis* (L.) R. Br. RUSTY POLYPOD. Fronds 2-8 inches long; laminæ lanceolate, green above, very chaffy beneath

once pinnate; pinnæ crowded, pinnatifid; pinnules nearly entire; stipe jointed at about one-half inch from the base. Not uncommon on exposed rocks. Very variable in northern sections. Middle of August. Europe and Asia.

157. *W. alpina* (Bolt) S. F. Gray. (*W. hyperborea*.) Fronds 2-6 inches long, laminæ green and nearly smooth on both sides, pinnate; the pinnæ sparsely pinnately lobed; stipe jointed. Mountain ravines of northern Vermont; Mt. Mansfield; Mt. Willoughby *Pringle*. August. Europe.

Appears in Vermont plants to intergrade with the preceding. *Eggleston*.

158. *W. glabellā* R. Br. SMOOTH WOODSIA Fronds 2-5 inches long; laminæ linear, smooth, pinnate, the pinnæ very obtuse and few lobed; lower pinnæ remote; stipe jointed. Mt. Willoughby and Mt. Mansfield; Bakersfield ledge, Vt., *Pringle* Gorham, N. H., *Deane*. "On moist, mossy rocks, mountains of Northern New England, etc."—*Prof. Eaton*. Early August. Europe.

Illustrated in Gray's Manual.

162. *W. obtusa* (Spring.) Torr. OBTUSE WOODSIA. Fronds 10-18 inches long; laminæ lance-oblong, bipinnate, nearly smooth; pinnæ triangular ovate, obtuse, the lowermost pairs remote; pinnules crowded, obtuse, incised, several sori to each division; indusium split into several lobes; stipe not jointed. Not common, especially in Rhode Island and eastern Massachusetts, and often disappearing in August. North America. July.

Illustrated by Meehan, Series II, Vol' 1.

TRIBE X, DICKSÒNIÆ.

DICKSÒNIA L'HER.

Indusium cup-shaped, adnate to the margin of the frond and enclosing the receptacle bearing the sorus. In the United States but one species.

163. *D. punctilobula* (Michx.) Asa Gray. HAY-SCENTED FERN. Fronds 2-3 feet long; laminae lanceolate, bipinnate; pinnæ lanceolate, acute, pinnatifid; lobes dentate; one sorus on upper margin of each lobe; stipe purplish black at the base; rachis hairy; under surface of laminae minutely glandular. Very common. North American. Late in August. Fragrant when drying.

Illustrated in Gray's Manual.

Sub-Family 3, *Schizæaceæ* Presl.

Sporangia sessile, having an articulated ring at the apex and opening by a longitudinal slit. Includes in our section only one species.

166. *Lygodium palmatum* (Bernh.) Swz. CLIMBING FERN. Fronds slender, climbing, 3-6 feet long; the lower pinnæ roundish, 5-7 lobed, distant in pairs, the upper several times forked, their ultimate divisions crowded and bearing the sporangia. North Amherst and Uxbridge, Mass.; Windsor, Conn. Scattered in small patches throughout Massachusetts; more common but local in Connecticut. Thickets and low woods in half shade. North American. September.

Illustrated in Gray's Manual.

A little plant of this sub-family, *Schizaea pusilla* Pursh, which has been found in Newfoundland, Nova Scotia and New Jersey, but not in the intervening territory, is to be expected in sandy bogs along the New England coast.

169. *S. pusilla* Pursh. Sterile fronds 1-2 inches long, linear, tortuous; fertile, 3-6 inches, bearing on top a few small crowded pinnæ in two rows. Companion plants, *Drosera* and *Lycopodium inundatum*.

For further account, with illustrations, see Gray's Manual, Meehan's "Ferns and Flowering Plants of North America," Series II, Vol. 1, *Linnean Fern Bulletin*, Vol. IV, No. 2, Underwood's "Our Native Ferns and Their Allies," and Eaton, Vol. 2, Plate xxiv.

Sub-Family 4, Osmundàceæ.

In the North Temperate zone but one genus, viz:

OSMÚNDA L.

Sporangia pedicelled, no ring, opening across the apex into two valves. Fronds tall, from large crowns; fruiting portion of fertile frond much contracted; spores green

170. *O. regàlis* L ROYAL FERN. FLOWERING FERN. Frond 1-6 feet high; laminae bipinnate; sterile pinnæ with several or many pairs of usually lance-oblong serrulate pinnules. Pinnules very variable. Fruiting panicle terminal, often 12 inches long, brown, sometimes quite leafy or even the whole upper half leafy. Common in swamps and damp places. Distributed throughout the world.

171. *O. Claytoniàna* L. CLAYTON'S FERN. Fronds 1-4 feet high; laminae once pinnate; pinnæ linear-lanceolate, pinnatifid; divisions oblong, obtuse. Fertile fronds taller than the sterile, having 1-5 pairs of the intermediate pinnæ contracted and bearing sporangia; fronds bluish-green. Pastures and thin woods; not as common as the next. North American. May.

172. *O. cinnamòmea* L CINNAMON FERN. Sterile fronds 1-5 feet long, laminae pinnate; pinnæ lanceolate, pinnatifid; divisions oblong, obtuse. Fertile fronds 6 inches to 2 feet long, contracted, bearing above the cinnamon-colored sporangia, and clothed below with cinnamon-colored wool; soon perishing. Very common in pastures, swamps and low grounds. Late May. North and South America and Japan.

Plants of all the species of *Osmunda* are found in some situations, fruiting when only five or six inches high.

Var. *frondosa* is an abnormal form in which the fertile frond takes on some of the characters of the sterile, such fronds being furnished below with one or more pairs of foliaceous pinnæ. Some fronds of this sort are three feet or more long with 8 or 10 inches of fertile pinnæ and 10 or 12 pairs which are sterile.

Another form has several pairs or more of fertile pinnæ below, while the upper part is that of a normally sterile frond. Rarely we find a normally sterile frond with two or three of the intermediate pairs fertile, thus mimicking the fertile frond of *O. Claytoniana*.

These abnormal fronds of *O. cinnamomea* occur most abundantly on ground which has been burned over, the ferns continuing to produce them for several years. They are for the most part later than the ordinary fertile fronds and should be looked for about the 10th of June.

LITERATURE.

A LARGE number of books relating to ferns have been published, some of them very expensive. To the beginner, who wishes for illustrations, and books easily accessible, can be recommended "A Fern Book for Everybody," by M. C. Cooke, (English,); and Edward Knobel's "The Ferns and Evergreens of New England." The latter contains outline figures of the more common species in Filices, Ophioglossaceæ and Lycopodiaceæ, including, however, a few which are probably not within the limits assigned. To these may be added Prof. Eaton's ferns of the Northern United States in the 6th edition of Gray's Manual, and Prof. Underwood's "Our Native Ferns and Their Allies," the latter giving description of all the American species of Pteridophyta north of Mexico. Prof. Eaton's "Ferns of North America" contains colored

illustrations of nearly all the North American species in Filices, and is a work much to be desired by the fern student, but is somewhat expensive and nearly out of print.

The recently published Vol. I of Britton & Brown's "Illustrated Flora of the Northern United States and Canada, Westward to the 102d Meridian," contains outline drawings of all known species in Filices within the given limits. Meehan's "Flowers and Ferns of the United States," of which only four volumes were published, contains fine illustrations of many species, those of such as occur within our limits being noted in the preceding text.

Those species of our Pteridophyta which are also native to Great Britain, and they are many, will be found illustrated in Anne Pratt's "Flowering Plants and Ferns of Great Britain"; "English Botany," Hooker's "British Ferns," and Newman's "British Ferns."

The ferns of the world, or such as were recognized in 1874, will be found described in Hooker & Baker's "Synopsis Filicum," and continued in Baker's "Summary of New Ferns," (1892.)

Those interested in fern culture will find much of interest in Robinson's "Ferns in Their Homes and Ours," and in Shirley Hibberd's "Fern Culture Made Easy," also in a series of articles by Robert T. Jackson in *Garden and Forest*, (Aug. and Sept., 1888.)

A useful book for those interested in microscopical investigations and in the study of the minute organization of this group is Campbell's recently published "Structure and Development of the Mosses and Ferns."

FAMILY II, OPHIOGLOSSACEÆ Lind.

PLANTS near allies of the ferns, but consisting of a stem with a single leaf. In *Ophioglossum* the leaf or sterile segment is entire, the veins are reticulated, and the sporangia in a simple spike. In *Botrychium* the sterile segment is more or less incised, the veins free, and the fructification in a panicle, or compound, or rarely simple spike.

OPHIOGLOSSUM L.

173. *O. vulgatum* L. ADDERS TONGUE Stem simple, 2-11 inches high, bearing one smooth, entire leaf and a terminal spike. Usually in meadows in moist, not boggy, places, scattered among the grass, etc. Overlooked rather than rare

“A nearly constant companion plant in eastern Massachusetts is *Habenaria lacera*.”—A. A. Eaton. This orchid is quite conspicuous when in bloom, and *O. vulgatum* may be expected in its vicinity. Throughout the New England states, and nearly cosmopolitan. Middle of July.

Illustrated in Gray's Manual, and by Knobel.

BOTRYCHIUM SWARTZ, GRAPE FERN.

177. *B. simplex* E. Hitchcock. Frond 1-3 inches high, rarely higher; sterile segment near the middle, entire or with few lobes; fertile segment simple, or once or twice pinnate; apex of both segments erect in the bud. Dry fields. “Abundantly scattered over Vermont, its habitat usually poor soil, especially knolls

of hill pastures."—*Pringle*. Conway and Plainfield, Mass., Berlin and Litchfield, Conn. Less common apparently near the coast, or perhaps overlooked, especially as it matures quite early. End of May. Northern portions of both Europe and America.

The vernalion of all the species of *Botrychium* native to New England is illustrated in Underwood's "Our Native Ferns and their Allies."

178. *B. Lunaria* (L.) Swartz. MOONWORT. Stem stout, 3–10 inches high; sterile segment sessile with fan-shaped or lunate divisions; fertile segment about equalling the sterile; panicle twice or thrice pinnate; apex of sterile segment bent over the fertile segment in vernalion; plant fleshy. Old pastures and similar situations. Rare in the United States, common in Europe and Northern Asia. In Connecticut—Oxford, *Oscar Harger*; West Cornwall, *Dr. F. W. Hall*. Woodstock, Me., *J. C. Parlin*. Middle of July.

Illustrated by Eaton, Anne Pratt and Underwood.

180. *B. matricaræfolium* A. Braun. Frond 1–12 inches high; sterile segment above the middle, usually much divided; fertile segment twice or thrice pinnate; apex of both segments turned down in the bud the sterile segment clasping and overtopping the fertile one. Damp woodlands; stations sometimes quite large, *B. Virginianum* being a frequent companion plant. Throughout our region, but not common. Middle of June. Europe.

181. *B. ternatum* (Thunb.) Swartz. Frond 2–16 inches high; leaf or sterile segment long petioled; petiole from near the base of the plant; fertile segment long-stalked, 2–4 pinnate, maturing its fruit in autumn. Ultimate divisions of the sterile segment varying much in form, giving rise to several named varieties, of which the following are found in our region:

a. Var. *intermedium*; ultimate divisions rhomboid-ovate, with toothed margins. Frequent, usually in half shade.

b. Var. *rotatifolium*; sterile segment small; ultimate divisions

ovate and semi-cordate. Southern N. H., *A. A. Eaton*; frequent along our northern border.

c. Var. *obliquum*; sterile segments having ultimate divisions obliquely lanceolate.

d. Var. *dissectum*; ultimate divisions dissected into numerous narrow divisions.

In New England, varieties *c* and *d* of this variable species are abundant, in pastures and on hillsides, fruiting best in sunny situations, and one or more varieties are native to nearly every part of the earth.

As all the *Botrychiums* are perennial, surviving many years, the plants reach their best development along walls and similar situations, being there more protected from injury. Plants are sometimes found with two or even three fertile segments and occasionally with two sterile segments. Middle of September.

Illustrated in Gray's Manual, and varieties in Eaton's Ferns.

182. *B. lanceolatum* (Gmel.) Angs. Frond 2-10 inches high; both sterile and fertile segments sessile at the top of the common stalk; sterile segment not at all fleshy, triangular, ternately pinatifid, like a reduced sterile segment of *B. Virginianum*. Damp shaded soil, especially near brooks. Not common, but yet probably often overlooked.

This species grows in damper situations than *B. matricariaefolium* and is to be looked for in low ground, especially when *B. Virginianum* is near at hand. Often found in the shade of the tall form of *Onoclea sensibilis*.

183. *B. Virginianum* (L.) Swartz. RATTLESNAKE FERN Sterile segment triangular, ternate, membranaceous, much divided, sessile at the center of the frond; fertile segment decompound. Plant commencing to fruit when but a few inches high, but surviving many years, reaching at times the height of 30 inches, occasionally with a double panicle. Not rare in rich woods. Late June. North America generally, Norway, Himalaya Mts., Australia.

Illustrated by Meehan, Series II, Vol. 1.

LITERATURE.

All the species in Ophioglossaceæ within our limits are figured in Eaton's "Ferns of North America," and outline drawings of most are contained in Knobel's "Ferns and Evergreens of New England."

FAMILY III, EUISETACEÆ DC.

RUSH-LIKE plants, often branched, with grooved and jointed stems, the joints sheathed. Fruit a terminal spike; spores all alike, furnished with four club-shaped filaments, (elaters), which curl around them spirally when moistened, but uncoil quickly when dry.

EUISETUM L.

184. *E. arvense* (L.) COMMON HORSETAIL. Stems of two kinds; the fertile 5-10 inches high, rather stout, pale brown, seldom branched, with loose and distant sheaths, soon perishing; spike $\frac{1}{2}$ -2 inches in length; sterile stems later, more slender, usually caudate, with copious four-angled branches. Common everywhere, especially in gravelly soil. Late April and early May. North temperate zone of both hemispheres.

Figured in Wood's "Botanist and Florist."

Var. *campestre* Schultz, is a state in which the stem has both fruit and branches, the fertile stem sometimes having a few branches at the base, or, which is the more striking form, the branched normally sterile stem having a spike of fruit which is occasionally fertile. The latter form is most usual in sandy situations, several hundred plants having been collected on a half acre of ground. Last two weeks in May. Europe.

187. *E. silvaticum* L. WOODLAND HORSETAIL. Sterile and fertile stems nearly alike, 8-16 inches high, furnished with very slender compound, recurved branches; stem about 12-furrowed; branchlets three-toothed. Common along the borders of damp woods; nearly sterile in deep shade. "The prettiest plant in existence."—*Shirley Hibberd*. Middle of May. Northern portions of the north temperate zone.

Illustrated in Underwood's "Our Native Ferns."

188. *E. palustre* L. MARSH HORSETAIL. Stems all alike, 1-3 feet high, sparsely branched, with about seven deep striae, and sheaths with about as many white-margined teeth; branches mostly five-toothed. Marshes. Knight's Island, Lake Champlain, *Ezra Brainerd*. Shore of Lake Champlain, *Pringle*; *A. J. Grout*. Abundant on the margins of St Johns river from the Aroostook northward, *M. L. Fernald*. Apparently confined to calcareous districts. Northern part of the north temperate zone. Early in June.

189. *E. litorale* Kuhnlewein. Stems of three kinds: 1—The normally sterile, 1-3 feet high, long caudate, often much branched. 2—Stems, often numerous, somewhat shorter, and bearing small abortive spikelets. 3—Stems 6-12 inches high, which are stouter and bear larger spikes with spores often perfect. Stems 6-16 grooved; sheaths loose, uppermost on fertile stems bell-shaped; branches of two kinds, the four-angled hollow, the three-angled solid. This plant is very variable and in eastern Massachusetts at least seems to intergrade between *E. arvense* and

E. fluviatile. Reported only from Maine, *M. L. Fernald*; shores of Lake Champlain, *Pringle*, and shores of Merrimac river at Amesbury, Mass., but probably frequent on sandy shores throughout our range. Early June. Common in Europe.

190. *E. fluviatile* L. (*E. limosum*.) PIPES. Stems all alike, 1-3 feet high, slightly many-grooved, and after fruiting more or less branched, especially near the middle; branches whorled, five-sided, or basal ones nearly round and upright; sheaths with about eighteen rigid, lanceolate, black teeth. Borders of ponds and muddy edges of streams; quite common. North temperate and Arctic zones. Late May and early June.

Illustrated in Gray's Manual.

194. *E. hiemale* L. SCOURING RUSH, Evergreen, 1-5 feet high, rather stout, sparingly branched; sheaths light colored, black at base and summit; teeth about twenty, early falling; stem rough; ridges with two lines of tubercles. Moist, shaded banks; generally distributed, but not abundant.

Illustrated in Millspaugh's "Medicinal Plants."

This plant fruits from hibernating terminal buds about May 20th, followed by usually small spikes, sessile just below the sheaths or sometimes on lateral branches. Later on, or about the 15th of June, stems which are the growth of the season are often found in fruit, continuing until August. North temperate and Arctic zones.

196. *E. variegatum* Schleicher. Stems slender, tufted, 6-18 inches high, branched from the base, 5-10 grooved; sheaths green, black above, with bristle pointed, deciduous teeth. Evergreen. Canaan, Conn.; Conway, Mass.; Bellows Falls and Glover, Vt.; Northern Maine, *M. L. Fernald*. Kennebec at Skowhegan, *J. A. Allen*. River banks in calcareous districts. Distributed throughout the northern portion of both hemispheres. Middle of June.

197. *E. scirpoides* Michx. Stems evergreen, 3-8 inches long,

very slender, numerous, tufted and entangled, three or four furrowed, with as many bristle-tipped teeth; spikes very small. Wet clayey banks in the shade of hemlocks. Norfolk and Plainfield, Conn. Green river road, Greenfield, Mass., *A. T. Beals*. Southbridge, *L. E. Ammidown*. Amesbury, *A. A. Eaton*. Frequent in the three northern states. Early May. Northern and Arctic regions of both hemispheres.

LITERATURE.

Figures, with full dissections of all the known species in the genus *Equisetum* are contained in Milde's elaborate "Monographia Equisetorum," and an abstract in his "Filices Europææ," both written in the Latin language. All the species in our limits, except *E. scirpoides* and *E. litorale* are illustrated in Hooker's "British Ferns," "English Botany," and Newman's "History of British Ferns," and all except *E. variegatum*, *E. litorale* and *E. scirpoides* are figured in Anne Pratt's "Flowering Plants and Ferns of Great Britain." Buysson's "Filicinæ de Europe" (French) contains much of interest relating to the Equisetaceæ.

FAMILY IV, LYCOPODIACEÆ Lind.

EVERGREEN, creeping perennials, with numerous small, crowded leaves in several or many ranks. Spores without elaters, all alike, marked with three radiating lines. Sporangia either in the axils of ordinary leaves, or in terminal spikes in the axils of modified leaves. In our limits one genus with eight species.

LYCOPodium L.

198. L. Selago L. **FIR CLUB MOSS.** Stems erect, 2-9 inches long; branches several times forked, forming a flat-topped cluster; sporangia in the axils of the crowded, glossy green, unaltered leaves, all down the stem, and so not forming a distinct spike; midrib of the leaves obscure. Mountain summits. Mt. Watatic, Mass, and frequent in the three northern states. Sept.-Dec. Everywhere in the cooler portions of the globe.

Figured in Hooker's "British Ferns," and by Anne Pratt.

199. L. lucidulum Michx. **SHINING CLUB MOSS.** Stems ascending, 6-12 inches long, forked; sporangia in irregular zones in the axils of shorter leaves interspersed with longer ones; leaves glossy green in eight rows, some of them turned downward; midrib distinct. Common in damp woods. Northern United States and eastern Asia. Sept.-Dec.

Figured in Knobel's "Ferns and Evergreens of New England."

200. *L. inundatum* L. MARSH CLUB MOSS. Small; sterile branches rather fragile, creeping, forking; leaves many ranked, soft, fine and curling; fertile stem 1-4 inches high, leafy, erect, bearing a thick spike; leaves of fertile stem and bracteal leaves of spike similar to leaves on sterile branches. Damp, sandy soil. Rather uncommon. Becoming more frequent near the coast but easily overlooked. *Vio^{la} lanceolata* and *Sporobolus serotinus* are frequent companion plants. Both of these are quite noticeable and where found *L. inundatum* is to be expected. Middle of Sept. Eastern North America and Europe.

Figured in Hooker's "British Ferns," and by Anne Pratt.

Var. *Bigelovii* Tuckerm. is much larger with sparser, larger and more rigid leaves; fertile stem often ten inches high. In sandy peat near the coast.

204. *L. annötinum* L. Main stems much branched; branches twice forked, ascending, leafy to the top, causing the spikes to appear sessile; leaves in five ranks, smaller at intervals, giving the branches a jointed appearance. Cold woods; rather unusual in Massachusetts, Rhode Island and Connecticut; frequent farther north. Late September. Northern America, Europe and Asia.

Figured in Hooker's "British Ferns."

Var. *pungens* has leaves shorter, more rigid and pointed. Mountain tops. Frequent on the high mountains of Maine, New Hampshire and Vermont.

Figured in Hooker's "British Ferns," and by Anne Pratt.

205. *L. obscurum* L. GROUND PINE. Rootstalk creeping underground; stems erect, simple at the base, copiously branched upwards, 6-8 inches high; leaves in six ranks, those in the lateral ranks incurved spreading, others shorter and appressed; spikes often numerous but solitary. Plant resembling a young evergreen tree. Woods; common. Middle of September. North America and eastern Asia.

Figured by Knobel.

Var. *dendroideum* has all the leaves alike and incurved spreading; branches more erect. Common.

Figured in Wood's "Botanist and Florist," page 413.

207. *L. sabinæfolium* Willd. GROUND FIR. Rootstalk mostly creeping underground; branches short, small, repeatedly forked flattened and clustered; leaves four ranked, small and appressed; spike short peduncled. Most resembles *L. complanatum*. Rochester, Vt., in cold, evergreen woods, altitude 1,500 feet. W. W. Eggleston. Chatham, N. H., elevation 3,500 feet, George Haley. In Maine, St. Francis, M. L. Fernald; Mt Katahdin, F. P. Briggs. Probably not rare in northern sections. Middle of September. Canada, Newfoundland. Rocky mountains.

208. *L. clavatum* L. RUNNING PINE. Extensively creeping above ground with ascending branches; usually a pair of spikes two inches long, on peduncles; leaves hair-pointed. Common in dry woods. Early in September. Northern parts of both hemispheres, and high mountains of the tropics. A very distinct form of this species is to be found in moist, sunny situations.

Figured in Hooker's "British Ferns," Underwood's "Fern Allies," and by Knobel and Anne Pratt.

210. *L. complanatum* L. EVERGREEN. Stems extensively creeping; branches repeatedly forked, fan-shaped; leaves very small, four ranked, appressed, of two kinds; peduncles long, with 2-6 spikes. Common and well known. Middle of Sept. North temperate zones of both hemispheres, and high mountains of the tropics. Large patches of this species are occasionally found having all the spikes bifurcate from near the base.

Figured by Knobel.

Var. *Chamaecyparissus* A. Braun, has narrower, less spreading, more erect, leafy branches; leaves less distinctly dimorphous; apparently maturing its spikes earlier.

FAMILY V, SELAGINELLACEÆ.

PLANTS small, leafy, with leafy, quadrangular spikes, bearing spore cases, (sporangia), with two kinds of spores, those containing the smaller or microspores representing the anthers in flowering plants, and the larger or macrospores representing the pistil. One genus, and with us two or three species.

SELAGINÉLLA BEAUV.

212. *S. rupestris* (L.) Spring. Plants growing in tufts, grayish green, resembling a moss; stems dividing into many branches; leaves densely imbricated, bristle-tipped. Dry, exposed rocks; common. Early September. Generally distributed throughout the world.

Illustrated in Gray's Manual.

214. *S. selaginoides* (L.) Link. Sterile stems creeping, slender; fertile stems larger ascending, unbranched, one-spiked; leaves lanceolate, ciliate. Resembles *Lycopodium inundatum*. Appears to have been found in our limits by Pursh only, who reported the plant from New Hampshire nearly a century ago. As it is frequent in Canada it is to be expected along our northern border. Early in September. Northern portions of Europe and America in damp places.

Illustrated by Anne Pratt as *Lycopodium selaginoides*; also in "English Botany," and Hooker's "British Ferns."

217. *S. apus* (L.) Spring. Stems tufted, small and slender, creeping, and much branched; leaves of two kinds, in four rows, those in the side rows larger and spreading, the others very small and appressed. Damp places in meadows; most frequent in southern portions of New England. Middle of September. Only in the United States east of the Rocky mountains.

This species has seldom been figured.

FAMILY VI, MARSILEACEÆ R. Br.

AQUATIC, creeping perennials, with either filiform or four-parted leaves. Fruit borne on peduncles arising from the rootstalk; sporocarps containing two kinds of spores. Consists of two genera, one of which is represented with us by a single species.

MARSÍLEA L.

221. *M. quadrifolia* L. Leaves long petioled, four-parted; leaflets deltoid, glabrous, usually floating; sporocarps on short peduncles from near the base of the petioles. Muddy shores. Bantam Lake, Litchfield, Conn., whence it has been introduced into several localities, among others, Lake Whitney, Conn., and Cambridge and Concord rivers, Massachusetts. August. Central Europe and Asia.

Illustrated by Meehan, Series I, Vol. 2.

FAMILY VII, SALVINIACEÆ.

S MALL, fugacious, floating annuals, much branched; branches covered with minute leaves, and sending out roots beneath. Sporecarps at the base of the branch, two or several together, of two kinds, one containing a single macrospore, and the other many microsporangia containing microspores. Contains two genera, one of which is represented in our limits.

AZÓLLA LAM.

228. A. Caroliniàna Willd. Plant reddish, much branched, deltoid, $\frac{1}{4}$ -1 inch broad; macrospore with three float corpuscles, its cuticle granulated; masses of microspores beset with bristles. Floating on the surface of the pond in the park at Springfield, Mass., and thence escaped into the Connecticut river. Adventive from California. August.

Illustrated with dissections in Gray's Manual.

FAMILY VIII, ISOETACEÆ Underw.

HERBS, aquatic or in moist ground, with simple, rush-like leaves in a rosette, from a fleshy trunk or corm. Leaves mostly with breathing pores (stomata) usually quadrangular, containing four vertical air channels divided by frequent cross partitions and furnished always with a central vascular bundle, and sometimes with others on the circumference (peripheral bast-bundles) Sporangia quite large, one-celled, orbicular to oblong, usually thin; sessile in a cavity at the axils of the leaves, more or less covered with a membrane (velum) produced from the edges of the cavity; those of the outer leaves usually containing globose macrospores, the inner containing very small, obliquely-oblong, three-angled microspores. Macrospores with a white silicious crust, which is marked by an equatorial line and on the upper surface by three equidistant longitudinal lines meeting at the apex of the spore (commissural ridges); silicious integument marked between the ridges with spines, tubercles, reticulations, etc. which serve in a measure to distinguish the species. Microspores white, grayish or light brown; glabrous, papillose, muriculate or spinulose.

One genus, comprising about fifty recognized species, of which eight species and five varieties are known within our limits.

In the following pages are described several forms in this genus which have not previously been noticed, and one of them, *I. Eatonii* previously confounded perhaps with the larger forms of *I. Englemanni*, has proved upon examination to be one of the most remarkable of the North American species.

ISÔETES L. QUILLWORT.

Characters the same as in the order

I. echinóspora. This European species as founded by DuRoi, has the following characteristics: Leaves 10-40, green or reddish at base, gradually tapering to a very slender elongated point; stomata altogether absent; sporangia unspotted; velum very narrow; macrospores nearly as in var. *Braunii*; microspores a little smaller. Abundant in northern Europe, extending into Iceland, but as yet not noticed in America.

Illustrated with full dissections by Motelay.

233. I. echinóspora Braunii Engelm. Leaves 10-30, green or reddish at base. erect, spreading, 2-10 inches long, a few stomata at their tips only; peripheral bast-bundles absent; sporangia pale-spotted; velum about one-half indusiate; macrospores 350-550 μ in diameter, covered with broad spinules which are often forked or dentate, and at times confluent; microspores 26-30 μ long, white or with a grayish tint; smooth.

Margins of ponds, often wholly submerged; also on the muddy shores of streams, or on the tidal tracts of rivers, often where the water is very brackish, as in the Penobscot, Kennebec and Merri-mac. Common throughout New England. Late August.

234. I. echinóspora robústa Engelm. Much stouter than the preceding; leaves 25-70, 5-8 inches long with abundant stomata on the whole surface; sporangia larger; otherwise not differing.

Type locality north end of Isle LaMotte in Lake Champlain, *Pringle*. Plants collected at Epping, N. H., on the Pautuckaway river by Mr. A. A. Eaton are similar in all respects to the type specimens.

235. I. echinóspora Boóttii Engelm. Leaves 10-20, slender, 4-10 inches long, erect when short, bright green, with a few stomata near the tip; macrospores with long, slender, simple spinules; otherwise like var. *Braunii*.

This form has not been noticed among plants of *I. echinospora* from western sections. It apparently has the same range as *I. Tuckermani*

Round Pond, Woburn, (type locality), and in a brook in Tofit swamp, Lexington, Mass., *W. Boot*. Also in Chebacco Pond, Essex, Mass., and at East Kingston, N. H.

236. *I. echinóspora muricata* Engelm. Leaves a bright green, 6-16 inches long, with few stomata; macrospores 400-580 μ with shorter, thicker and more confluent spinules; otherwise like var. *Braunii*.

Woburn creek, (type locality), and Abajona river near Boston, Mass., *W. Boot*. Mouth of Pompanusuc river, Norwich, Vt.; Powow river, East Kingston, N. H.; margin of the St. Johns at Madawaska, Me., *M. L. Fernald*.

When the leaves of this variety are very long the upper part assumes a spiral form, leaves of 12 or 15 inches having the upper half twisted into several convolutions, the plants in this case being entirely submerged.

230. *I. lacústris* L. Leaves 10-30, dark green, somewhat rigid, pointed but scarcely tapering, 3-6 inches long, without stomata or peripheral bast-bundles; sporangia unspotted; velum about one-third indusiate; spores of both kinds large; macrospores 500-800 μ in diameter, spherical, marked all over with short, thin flexuous ridges; immature spores often appearing granulated; microspores 35-45 μ long, smooth, light gray commissural ridges cristate.

Usually gregarious in gravelly soil on the bottom of lakes under 1-5 feet of water. In New England this species has been rarely collected: Fresh Pond near Cambridge, Mass., *W. Boot*. Uxbridge, Mass., *J. W. Robbins*. Echo Lake, N. H., *Prof. Tuckerman*. Brattleboro, Vt., *Frost*.

Plants collected on the tidal tract of the Merrimac river, six or eight miles from its mouth and near low water mark, are simi-

lar in all respects to European specimens of *I. lacustris* collected by Durieu de Maisonneuve. The plants at this station are but few, being interspersed among those of *I. echinospora Braunii* and are perhaps from spores brought down the river by the current. This species may be expected to occur more abundantly in the northern portions of New Hampshire and Maine.

I. lacustris is reported in Bishop's Catalogue of the Plants of Connecticut (1896) as having been found at North Stonington, but an examination of a much larger number of specimens from this locality has shown that they should be referred to *I. Tuckermanni*.

I. lacustris is abundant in the lakes of northern and central Europe.

Illustrated in Gray's Manual, and spores and leaf sections by Motelay. Early in August.

232. *I. Tuckermanni* A. Braun. Leaves dark olive, often tinged with red, very slender and fragile; outermost recurved spreading, usually sub-distichous and spirally twisted, 2-5 inches long; peripheral bast-bundles absent; stomata few or none; sporangia small, orbicular, rarely pale spotted; velum one-third indusiate; macrospores 450-750 μ in diameter, marked on the upper half with parallel or often anastomosing ridges, the lower half irregularly reticulated; microspores 25-38 μ long, dark gray, nearly or quite smooth.

Usually gregarious, growing in gravelly soil immersed in from one to four feet of water. Type locality, Mystic river, *Prof. Tuckerman*; and in Mystic, Spy and Horn ponds near Boston, Mass., *W. Boot*. Abundant on the east side of Chebacco pond, Essex, Mass., and at Lake Atitash, Amesbury, Mass., growing in company with *I. echinospora Braunii*, which however is always found nearer the shore and often wholly emerged. This species is plentiful also on the muddy shores of the Merrimac river at Newburyport, Mass., growing in places subject to a tide of two or three feet. Fifteen or twenty per cent. of the plants at Lake Atitash are trilobed.

Plants from all these localities contain macrospores of normal size, that is, not larger than $560\ \mu$ in diameter, as given by A. Braun the founder of the species, but it has remained for Mr. A. A. Eaton to extend the known range of this species into New Hampshire, and to there discover plants having much larger spores than those previously recorded; plants from Country pond, Kingston, N. H., having spores $580\ \mu$ in diameter, from Pautuckway pond $700\ \mu$ in diameter, and from Pautuckaway river, Epping, N. H., $750\ \mu$, the spores of the latter being as large as any of *I. lacustris*, but sculptured like those of *I. Tuckermanni* in a very characteristic manner.

Dr. C. B. Graves has also sent a large number of plants of this species from North Stonington, Conn. *I. Tuckermanni* matures its spores earlier than any other of our species, the outer leaves often falling away early in July.

238. *I. saccharata* Engelm Leaves 10-20, dark green, spreading, subulate, 2-5 inches long; stomata abundant; peripheral bast-bundles wanting; sporangia spotted; velum narrow; macrospores $400-550\ \mu$, "as if sprinkled with minute grains of white sugar,"—*Engelm.* Microspores $24-38\ \mu$, papillose. Type locality on Wicomico and Nanticoke rivers, eastern shore of Maryland, above salt water, but between high and low tides. Scattered on a thin stratum of mud covering a bed of gravel, *W. M. Canby*, Piney Creek cove and Back Creek, Elk river, Maryland, *T. C. Palmer, Botanical Gazette, Jan., 1895* Tidal tract of the Merrimac river near the mouth of the Artichoke, *R. D.* Plants like those from Elk river.

At Lloyd's creek, Sassafras river, Md., plants intermediate in spore sculpture between *I. saccharata* and *I. riparia* have been collected by Mr. Palmer; *Botanical Gazette, Apr. 1896.*

239. *I. riparia* Engelm. Leaves 15-30, dark green, nearly erect, 4-12 inches long; stomata abundant; peripheral bast-bundles wanting; sporangia distinctly spotted; velum one-fourth to three-fourths indusiate; macrospores often large, $450-650\ \mu$ in di-

ameter with thin, jagged crests, sometimes anastomosing, especially on the lower surface; commissural ridges cristate; microspores tuberculated, 26–32 μ .

This species may be distinguished from *I. lacustris*, which it somewhat resembles, by the crested ridges of its macrospores, which often form reticulations on the lower side of the spore; by the presence of stomata on the leaves; a spotted sporangium with a wider velum, and also as shown by Mr. T. Chalkley Palmer, by its being polygamous.—*Botanical Gazette*, Apr. 1896.

Type locality, banks of the Delaware river near Philadelphia, *Nuttall*; Wm. S. *Zantzinger*. Uxbridge, Mass., *J. W. Robbins*. Brattleboro, Vt., *C. C. Frost*. Lake Saltonstall, Ct., *Setchell*. Amherst Catalogue, *Tuckerman*. Banks of the Powow river, East Kingston, N. H., and in the Merrimac at Newburyport, Mass., *R. D.*

This species when living as is often the case in the mud on the tidal tracts of rivers, when near high water mark; is commonly small, with leaves two or three inches long, but when submerged for a greater portion of the time the plants become larger.

[The description of the species next following is contributed by Mr. A. A. Eaton.]

I. foveolata A. A. Eaton, n. sp. Plant amphibous; trunk bilobed, rarely trilobed, $\frac{1}{2}$ – $\frac{3}{4}$ inch in diameter; vernal leaves not seen estival 15–70, very stout, 2–6 inches long, pink even when dry, or rarely dark green; stomata few, near the tips only; peripheral bast-bundles absent; diameter of the assembled sporangia often $1\frac{1}{4}$ inches; many plants containing only macrospores; velum one-fifth to one-third indusiate; ligule round-ovate, little exserted; sporangia thickly sprinkled with very dark cells, these sometimes collected in groups; macrospores 380–560 μ , average 440 μ , tetrahedro-globose with a thick integument ($5\frac{1}{2}$ μ), covered beneath with very thick-walled reticulations so that the openings appear like little pits, (whence the name); above, the reticulations are elongated, especially next the commissures, or the walls even parallel anastomosing, or in isolated groups; microspores dark brown,

22-35 μ long, densely reticulated, and usually with a few papillæ.

Abundant on the muddy banks of the Pautuckaway river at Epping, N. H., and flats of the mill-pond of the same river; West Epping, associated with *I. echinospora muricata*, *I. echinospora robusta*, *I. Eatoni*, *I. Engelmanni* and *I. Tuckermanni*, or often alone. A. A. Eaton. Flats at East Kingston, N. H., Dodge. Aug. 1896.

I. Eatoni Dodge, n sp. Amphibious; trunk very large, $\frac{1}{2}$ -1 $\frac{1}{4}$ inches in diameter; bulb diameter sometimes 2 $\frac{3}{4}$ inches. Vernal or subaqueous leaves sometimes 200, reaching the length of 28 inches; estival leaves much shorter, 3-6 inches; stomata abundant; peripheral bast-bundles irregular in occurrence; sporangia large, pale spotted; macrospores small, 300-450 μ in diameter, tetrahedro-globose, their sculpture labyrinthiform-convolute; microspores 25-30 μ , smooth or slightly papillose. Plant polygamous. Vernal form the middle of July; estival form Aug.-Sept.

East Kingston, N. H., July, 1895, and Epping, N. H., August, 1896, A. A. Eaton. For detailed description with illustrations, see *Botanical Gazette*, January, 1897.

241. I. Engelmanni A. Braun. Leaves 15-100, bright green, 4-20 inches long, furnished with four peripheral bast-bundles; stomata abundant; sporangia unspotted; velum narrow; macrospores clear white, 350-550 μ in diameter, delicately honeycomb-reticulated; microspores light colored, 24-28 μ , smooth or nearly so.

This plant when growing in merely damp places, as is often the case, or in places where it is for the greater part of the time out of water, produces erect-spreading leaves 4-6 inches long. In situations subject to heavy inundations during the winter and the spring, the leaves of early growth are much longer, at times reaching the length of 18 or 20 inches. As the water recedes the upper portion of the leaves floats on the surface. Finally the plants become nearly or quite emersed and the long leaves prostrate on the mud, decay and are succeeded by a shorter, nearly erect growth,

the earlier leaves of which often mature their sporangia before the close of the season. It is only in situations where the plants are thus alternately submersed and emersed that they attain a good development of leaves and trunk.

This is probably the life history of all the amphibious species of Isoetes, as *I. Eatoni*, *I. foecolata*, etc., excepting those, which, like *I. riparia* and *I. saccharata*, grow under the influence of tide water.

Connecticut—Meriden, *F. W. Hall*; Waterford, *C. B. Graves*
Rhode Island—Newport, *W. G. Farlow*. Massachusetts—Amherst, *Prof. Tuckerman*. Maine—*M. L. Fernald*. Abundant in eastern Massachusetts. Probably throughout our range, but reported principally from near the coast. In ditches, brooks and slow running streams, usually in clayey soil.

Illustrated with full dissections by Motelay.

241.1. *I. Engelmanni gracilis* Engelm. A form with a few (8-12) very slender leaves, 9-12 inches long. Bast-bundles weak or but two or three of them. In deep water or often in shaded localities. As all the species of this group attain their largest growth by abundance of sunlight, *I. Engelmanni* indeed requiring to become terrestrial or nearly so for a portion of the time, it is probable that the form *gracilis* is one of arrested development.

Westville, Conn., *Setchell*. Brattleboro, Vt., *Frost*. Newport, R. I., *D. C. Eaton*. Hampton Falls, N. H., *River Parker*, Newbury, Mass., *R. D.* South Hampton, N. H., *A. A. Eaton*

LITERATURE.

Baker's "Fern Allies," London, 1887, contains descriptions of all species recognized at the time of publication.

Britton & Brown's "Illustrated Flora of the Northern United States and Canada," contains illustrations of all the Fern Allies

within the specified limits, those of the *Isoetes* being accompanied with figures of the macrospores..

"Ueber die *Isoetes* Arten der Insel Sardinien," von Alexander Braun, Berlin, 1864, an interesting discussion of the Quillworts, in which our species are frequently referred to.

"The Genus *Isoetes* in North America," by George Engelmann, St. Louis, 1882. An important contribution to the subject. An abstract is contained in Gray's Manual.

"Monographie des *Isoetæ*," par L. Motelay et Vendryes Bordeaux, 1884; one hundred pages and ten plates.

"The Distribution of *Isoetes*," L. M. Underwood, *Botanical Gazette*, pages 89-94, 1888.

"The Structure and Development of the Mosses and Ferns," by Douglass H. Campbell: Macmillan & Co. 1895.

REMARKS ON THE GENUS ISOETES.

THE collection, examination and identification of the species in this genus native to New England, as elaborated by Dr. Engelmann in his monograph, "The Genus *Isoetes* in North America," is doubtless a task attended with some difficulties. Although these north-eastern states seen particularly rich in both species and varieties, and certainly with no lack of individual plants, yet it is only in very dry seasons that the larger portion, including nearly all the best developed plants, are easily accessible; while *I. lacustris* and *I. Tuckermanni* are nearly always deeply submerged. Plants of *I. Engelmanni* are often found growing in merely damp situations, but they are much smaller and less developed than those which are immersed. It requires also, considerable experience before the eye readily distinguishes these plants from the immature sedges and rushes which ordinarily are their companions.

There are however some locations in which these difficulties are not encountered; as near the mouth of rivers where the plants are left dry by the receding tide; in places where the water has been nearly drawn off from ponds and streams used for manufacturing purposes; or along the margins of brooks.

To illustrate the abundance of these plants in eastern Massachusetts and south-eastern New Hampshire, it might be mentioned that in Seabrook, N. H., a pond usually covering several acres, which was so reduced in size by the drought of 1894 that the water nearly disappeared, was found to contain such an abundance of the quillworts that they formed a nearly continuous green carpet. The only species noticed was *I. echinospora Braunii*. In October, 1895, at the head-gate on Powow river at Amesbury, Mass., there was noticed floating on the surface of the river inside the gate, which at that time was shut but leaking badly at the bottom, such a mass of *Isoetes* leaves that they might have been collected by wheelbarrow loads. Many of these leaves contained sporangia and about all the New England species and varieties were represented. At Hampton Falls river, Hampton Falls, N. H., the banks on both sides are lined with plants of *I. Engelmanni*. It is probable that many stations of like nature are to be found in New England, and in fact in other sections of the country, and that they often escape observation.

It is only in situations fully exposed to the sun that the quillworts are to be expected. Although at times, a few scattered plants may be found growing in shady places, they are invariably few leaved and for the most part sterile, their numbers being maintained presumably by spores brought by the current from more favorable localities.

With a strong lens and some experience, the various species in this genus can often be determined, but it seems probable that they intergrade at times, *I. Tuckermanni* for instance, appearing to hybridize with *I. echinospora*. For any satisfactory work with the quillworts, a compound microscope is indispensable. Those

wholly unacquainted with the use of the microscope, will seek instructions in some manual specially devoted to the use of this instrument, but it seems desirable to make a few general observations upon the structure and examination of these plants.

The sporangia are thin-walled, membranaceous sacs, the walls consisting of two layers of cells, the outermost layer translucent, but in a few of our species mixed with brown (schlerenchym) cells, giving the sporangia a spotted appearance. The velum in all our species only partly covering the sporangium is easily seen with the naked eye in fresh plants; in the case of dried specimens it is well to soak the whole plant in water previous to examination. At the leaf base and just above the sporangium is a small, triangular, membranaceous organ (ligule) whose function is not well understood. It can be seen to good advantage only in fresh leaves and is apparently of small diagnostic value.

The macrospores should be examined when perfectly dry, with a power of 50-75 diameters; and it will be found that if they are heated sufficiently to cause them to assume a light brown tint, as by holding them on a glass slip over the chimney of an ordinary lamp, that the sculpture will become more evident by reason probably of a diminution of internal reflections. The microspores are very minute bodies, having the appearance of a fine powder when removed from the sporangium. They are about one one-thousandth of an inch in length, and in a single sporangium of some species are probably contained by millions. They may be examined under water or in balsam by transmitted light, and should also be viewed by reflected light as opaque objects, with a magnification of 300-400 diameters. Before any conclusions are drawn regarding the condition of the surface of either macrospore or microspore, care should be taken that those under examination be perfectly mature, as unripe spores have very frequently an appearance differing much from that of those fully developed. This applies also to spores from young plants.

In the preceding descriptions the dimensions of the spores are

given in thousandths of a millimetre, one of which is represented by the Greek letter μ . This unit is one twenty-five thousandth part of an inch, very nearly. The measurement of the spores is best taken by a micrometer attached to the eye-piece of the microscope.

To find the stomata (absent only in *I lucustris*) is not at all difficult when fresh leaves are procured, or even in those which have been preserved in alcohol. Fragments of the epidermis are easily removed, and with a power of 200–300 diameters the stomata when present are easily distinguished. When apparently absent the tip of the leaf should be carefully examined, as in some species notably in *I Tuckermanni*, and in some forms of *I. echinospora*, they are absent elsewhere. In the case of dried specimens, short pieces of the leaf may be first soaked, and then boiled preferably in a weak alkaline solution. Portions of the epidermis can then be scraped off and examined; or if the manipulator is sufficiently skillful, the section may be opened by a slit, and the whole internal portion removed, leaving the epidermis in good condition for examination. If the leaves have become dark brown and partly decomposed, their examination requires considerable patience.

In searching for bast-bundles in the leaves, it is necessary to make the thinnest possible transverse sections. Elder pith, which can be found at most country roadsides, or is procurable from the watchmaker, furnishes a good and ready means of making these thin sections. When selecting the elder stalks those of the previous year should be chosen as the pith is large and the woody portion readily separable. A short piece of the pith is split nearly to the end, a portion of the leaf is placed lengthwise in the slit, and by the use of a sharp razor and some patience, very thin sections may be obtained. These sections may then be transferred by a moistened needle to a glass slip, or first floated on water and removed by a pipette. A weak solution of caustic soda or potassa or even of baking powder is then added, a cover glass placed over all and the slip heated over a lamp until the boiling point of the

water is reached. A glass slip having a shallow cavity or cell in the center is very useful in examining these thin sections, which when placed in the cell are not liable to be crushed by the cover glass.

If bast-bundles be present and the sections be sufficiently thin they will then be seen by transmitted light and under a magnifying power of 300 diameters, as a bundle of brown cells, quite different from the cells of the epidermis. A bundle of bast cells in the center of the leaf is to be seen in all species. The peripheral bast cells are located in our species as follows: When four are present, three will be found on the upper or ventral side of the leaf—one at each end and one midway—and one in the center of the dorsal or lower side, all of them being close to the epidermis. When two only are present, those at the terminations of the ventral side are wanting.

Leaves or whole plants of the quillworts can be preserved in good condition for any length of time, if kept covered with alcohol or an aqueous solution of formaline, the latter being preferable in situations where it is not liable to freeze. It is quite possible however to detect bast-bundles when present, in the leaves of pressed specimens, the sections by boiling resuming in a great measure their original form. A small test tube such as is used by chemists when held in the flame of a lamp, serves a good purpose in boiling section of *Isoetes* leaves.

Great care should be taken in drying and pressing the larger plants of this genus. The dryers should be frequently changed, and if the specimens are very large and filled with moisture, they should be divided through the trunk by making a section at right angles to its natural division. The trunk in all our species is normally bilobed but individual plants are found which are trilobed, this occurring most frequently with *I. Tuckermanni*.

A CHRONOLOGICAL LIST.

The subjoined list is intended to be a catalogue of all the known species and important varieties in the Vascular Cryptogams growing without cultivation in the New England states; their chronological arrangement as regards best time for collection; and a memorandum, which with the assistance of references to their description, etc., shall assist the collector in obtaining them.

The best time for collection is usually just before the spores mature, but with some species, notably in the genus *Dryopteris*, the condition of the indusium is also be considered. In the case of some of the *Equisetaceæ* the fertile stems are in bad condition, when the sterile become fully developed. Species in *Filices* having dimorphous fronds, mature the fertile fronds so late that the sterile ones are not fit for collection, or the fertile are mature before the sterile are well developed. In such cases dates have been given for both. Some species mature their fertile fronds quite early but continue to produce a few scattering ones until late in the season. In this event only the earlier and more abundant are considered in this list, Some species, as *Asplenium viride* and *Asplenium montanum* are in fair condition at all seasons, while others in *Equisetum* and *Botrychium* have a fruiting season of not more than a week or ten days in duration,

The development of the earlier species is of course affected to some extent by the difference in seasons, but when it is considered that the fruiting season of no species has very narrow limits, that the variation in time of maturing in successive years is but small, and that the object is not usually to collect plants in quantity, it becomes evident that an average date may be selected which is quite likely to serve all purposes of the collector.

Differences of latitude are also to be considered, as is also the proximity to the coast. For such species as grow in eastern Mas-

sachusetts, the dates given are considered to be correct for the latitude of Boston or about 42 degrees north, and for the earlier species a few days should perhaps be added or subtracted in extreme northern or southern sections.

This list, in its chronological features, is the outgrowth of five seasons of observation and inquiry, and although doubtless susceptible of improvement, it is hoped to be a step in advance of the knowledge at present available on the subject, as our sources of information are often silent, indefinite, or altogether misleading.

CHRONOLOGICAL LIST.

May 5— <i>Equisetum arvense</i> (fertile stems)	Page 23
“ 10— <i>Equisetum scirpoides</i>	25
“ 15— <i>Equisetum silvaticum</i> (fertile)	24
“ 20— <i>Equisetum hiemale</i>	25
“ 20— <i>Equisetum arvense campestre</i>	24
“ 25— <i>Botrychium simplex</i>	20
“ 25— <i>Osmunda Claytoniana</i> (fertile)	17
“ 30— <i>Equisetum litorale</i>	24
“ 30— <i>Osmunda cinnamomea</i> (fertile)	17
June 5— <i>Onoclea Struthiopteris</i> (fertile)	14
“ 5— <i>Equisetum fluviatile</i>	25
“ 5— <i>Equisetum palustre</i>	24
“ 10— <i>Equisetum arvense</i> (sterile)	23
“ 10— <i>Osmunda cinnamomea frondosa</i>	18
“ 15— <i>Equisetum variegatum</i>	25
“ 15— <i>Botrychium matricaræfolium</i>	21

June 15— <i>Equisetum silvaticum</i> (sterile).....	Page 24
“ 20— <i>Osmunda regalis</i>	17
“ 20— <i>Osmunda Claytoniana</i> (sterile).....	17
“ 20— <i>Osmunda cinnamomea</i> (sterile)	17
“ 25— <i>Botrychium Virginianum</i>	22
“ 25— <i>Onoclea sensibilis</i> (sterile).....	14
“ 30— <i>Phegopteris dryopteris</i>	8
“ 30— <i>Dryopteris spinulosa</i>	12
“ 30— <i>Dryopteris spinulosa intermedia</i>	12
“ 30— <i>Dryopteris spinulosa dilitata</i>	13
July 5— <i>Cystopteris fragilis</i>	13
“ 5— <i>Dryopteris acrostichoides</i>	8
“ 5— <i>Dryopteris acrostichoides incisa</i>	9
“ 10— <i>Phegopteris Phegopteris</i>	8
“ 10— <i>Dryopteris cristata</i>	10
“ 18— <i>Isoetes Tuckermanni</i>	36
“ 10— <i>Dryopteris Bootii</i>	13
“ 15— <i>Botrychium Lunaria</i>	21
“ 15— <i>Woodwardia Virginica</i>	3
“ 15— <i>Ophioglossum vulgatum</i>	20
“ 15— <i>Dryopteris cristata x marginalis</i>	12
“ 20— <i>Pellæa gracilis</i>	2
“ 20— <i>Isoetes Engelmanni</i>	39
“ 20— <i>Woodsia obtusa</i>	15
“ 25— <i>Pellæa atropurpurea</i>	3

July 25— <i>Cystopteris bulbifera</i>	Page 13
“ 25— <i>Asplenium montanum</i>	6
“ 30— <i>Dryopteris Goldieana</i>	11
“ 30— <i>Dryopteris marginalis</i>	11
“ 30— <i>Dryopteris cristata Clintoniana</i>	11
Aug. 5— <i>Isoetes lacustris</i>	35
“ 5— <i>Asplenium ruta-muraria</i>	6
“ 5— <i>Camptosorus rhizophyllus</i>	7
“ 5— <i>Asplenium filix-fœmina</i>	7
“ 10— <i>Polypodium vulgare</i>	1
“ 10— <i>Woodsia alpina</i>	15
“ 10— <i>Woodsia glabella</i>	15
“ 10— <i>Isoetes Engelmanni gracilis</i>	40
“ 10— <i>Adiantum pedatum</i>	2
“ 10— <i>Dryopteris fragrans</i>	10
“ 10— <i>Asplenium ebenoides</i>	4
“ 10— <i>Dryopteris aculeata Braunii</i>	9
“ 15— <i>Woodsia Ilvensis</i>	14
“ 15— <i>Asplenium acrostichoides</i>	6
“ 15— <i>Marsilia quadrifolia</i>	31
“ 15— <i>Isoetes riparia</i>	37
“ 15— <i>Onoclea sensibilis obtusilobata</i>	14
“ 15— <i>Botrychium lanceolatum</i>	22
“ 20— <i>Asplenium platyneuron</i>	5
“ 20— <i>Dicksonia punctilobula</i>	17

Aug. 20— <i>Dryopteris Noveboracensis</i>	Page 9
“ 20— <i>Asplenium trichomanes</i>	5
“ 20— <i>Asplenium trichomanes incisum</i>	5
“ 25— <i>Onoclea Struthiopteris</i> (fertile)	14
“ 25— <i>Isoetes foveolata</i>	38
“ 25— <i>Isoetes Eatonii</i>	39
“ 25— <i>Phegopteris hexagonoptera</i>	8
“ 25— <i>Isoetes echinospora</i> (and varieties)	34
“ 30— <i>Dryopteris Thelypteris</i>	10
“ 30— <i>Woodwardia areolata</i> (sterile)	4
“ 30— <i>Azolla Caroliniana</i>	32
Sept. 5— <i>Selaginella rupestris</i>	30
“ 5— <i>Lycopodium complanatum chamæcyparissus</i>	29
“ 5— <i>Pteris aquilina</i>	6
“ 10— <i>Lygodium palmatum</i>	10
“ 10— <i>Selaginella selaginoides</i>	32
“ 10— <i>Asplenium angustifolium</i>	6
“ 10— <i>Lycopodium clavatum</i>	29
“ 15— <i>Lycopodium obscurum</i>	28
“ 15— <i>Lycopodium obscurum dendroideum</i>	29
“ 15— <i>Lycopodium inundatum</i>	28
“ 15— <i>Lycopodium inundatum Bigelovii</i>	28
“ 15— <i>Asplenium viride</i>	6
“ 15— <i>Dryopteris simulata</i>	9
“ 15— <i>Onoclea sensibilis</i> (fertile).....	14

Sept. 15--	<i>Botrychium ternatum</i> (and varieties)	Page 21-22
“ 20--	<i>Lycopodium complanatum</i>	29
“ 20--	<i>Selaginella apus</i>	31
“ 20--	<i>Lycopodium sabinæfolium</i>	29
“ 25--	<i>Lycopodium lucidulum</i>	27
“ 25--	<i>Lycopodium Selago</i>	27
“ 25--	<i>Lycopodium annotinum</i>	28
“ 25--	<i>Lycopodium annotinum pungens</i>	28
“ 30--	<i>Woodwardia areolata</i> (fertile).	4
Oct. 10--	<i>Lycopodium alopecuroides</i> (Appendix)	52

APPENDIX.

Page 2, **67**. Instead of *P. grácilis*, read *P. Stéleri* (S. G. Gmel.) Watt.

Page 9, **127**. Instead of *D. aculéata Braùnii* read *D. Braùnii* (Spenner) Underw.

These changes are made to accord with the recently published "Illustrated Flora of the United States and Canada," by Britton and Brown.

Page 9, **131**. Add:—Illustrated and described by Mr. G. E. Davenport in *Garden and Forest*, Dec. 2. 1896.

Page 12. *D. cristata* \times *marginalis*. As above in *Garden and Forest*, Nov. 4, 1896.

Page 28. Insert: **202. L alopecuròides** L. Habit of *L. inundatum*; sterile branches 2-10 in long, ramose, with many squarrose, bristly serrate, spinulescent teeth; fertile stems 2-8, rigid, erect, 2-10 in. high, bearing erect appressed leaves and simple spikes; largest spikes 1-1½ in. long; spikes gradually reduced until the last one or two stems have none at all; scales of spike erect-appressed, with rigid slender points and several bristle-tipped serratures at the sub-ovate base.

Sandy swamp among cranberries, south end of Plum island, Ipswich, Mass To be expected in cranberry bogs on Cape Cod and along the shore of Long Island Sound. Early in Oct.

Page 30, **214**. For *S. selaginòides*, read *S. selaginòides*.

Page 31, **217**. For *S. apùs* read *S. àpus*.

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